Mid-Jurassic or Dogger

The Mid-Jurassic epoch opened with a development of regressive facies across the British Isles (Figure 12.13). Fluvio-deltaic environments spread southwards into northern Britain and the North Sea, whilst central England and (at times) western Scotland (Hudson, 1964, 1983) became sites of shallow lagoonal sedimentation. Southern England was generally an area of marine shallows where extensive successions of shallow-water carbonates were laid down in the absence of terrigenous elastic detritus. In southwest England and farther to the south across Europe, fully marine Tethyan conditions prevailed. Periodic transgressions spread these marine conditions northwards. To the north of the Scottish landmass, boreal marine assemblages occasionally spread southwards into the region.

Fossil fishes have been found in numerous localities in the Mid-Jurassic (Aalenian–Callovian) of southern England and western Scotland, but the most productive sources for fishes are mainly in rocks of Bathonian and Callovian age. The typically shallow-water lagoonal and littoral marine facies of the Bathonian (e.g. the Forest Marble) have produced mixed fresh, brackish and marine fish assemblages and some important small amphibian remains, while the Callovian Oxford Clay is famous for its exceptional fish fauna that occurs throughout the outcrop.

There are relatively few fish sites in the Aalenian–Bajocian succession of Britain. In southern Britain shallow-marine carbonates, the Inferior Oolite Group, were laid down under high-energy conditions, although for a time in the Lower Bajocian these were emergent when a karstic landscape developed over much of the English Midlands (Bradshaw *et al.,* 1992). Across parts of northern Britain, a river flood-plain environment prevailed (Ravenscar Group, Aalenian–Bathonian), where four episodes of alluvial facies were deposited upon a broad coastal plain and were separated by interludes of transgressive marine deposition (Hemingway and Knox, 1973; Cope *et al.,* 1980a). The vertebrate remains are largely confined to the southern carbonates and consist mainly of scattered teeth, scales and bones. Details of sites can be obtained from Fox-Strangways (1892) and H.B. Woodward (1894) as well as from museum records and other unpublished sources.

The Bathonian succession is much more fos-siliferous than the underlying Middle Jurassic. It is characterized by a regressive marginal marine sequence in the British Isles, and although in southern Britain shallow marine conditions continued unabated from the Bajocian, in central regions a network of island bars, lagoons and coastal marshes had developed over a Bahaman-type carbonate platform. The Bathonian rocks of England are often referred to as the 'Great Oolite Series' (Torrens, 1980b). The Great Oolite Group (*sensu stricto*)encompasses the Lower Fullers Earth (and its lateral variations; *zigzag Zone–?hodsoni* Zone), the 'Great Oolite' (*sensu* 19th–early 20th century workers, e.g. Woodward, 1894; Richardson, 1911a, 1929; *zigzag Zone–aspidoides* Zone), the Forest Marble Formation (*aspidoides Zone–discus* Zone) and the Lower Cornbrash (*discus* Subzone; Arkell, 1931; Cave, 1977). The Great Oolite Group of the English Midlands is a classic example of this interplay between non-marine and marine influences, and numerous vertebrate finds have been made from this region. The majority of the remains come from channel, lagoonal and lacustrine deposits, and these document a number of major faunal changes.

Fish remains are common in the 'Great Oolite' and Forest Marble of Gloucestershire, Oxfordshire and Dorset in particular, but localities are known elsewhere throughout the British Bathonian. The commonest fossils in these rocks are teeth, tooth plates and the thick ganoid scales of pycnodonts and semionotids. Hybodont shark teeth are also fairly common, and acid-prepared residues include many 'caturid'-type neopterygian teeth, shark denti-cies and teeth of neoselachians. Amphibian remains have also been recovered from several localities in the 'Great Oolite' and Forest Marble Formation. References include Phillips (1871), H.B. Woodward (1894), A.S. Woodward (1887a, 1887b, 1889a, 1890, 1910), von Huene (1926), Arkell (1933, 1947a, 1947b), Torrens (1968, 1969a, 1969b), Palmer (1973, 1979), Sellwood and McKerrow (1974), Freeman, (1976), Metcalf *et al.* (1992), Evans (1992) and Evans and Milner (1994).

The lagoonal facies of the Great Estuarine Group (Bathonian) of the Inner Hebrides in west Scotland have been known as sites for fossil vertebrates since the mid-19th century when Hugh Miller (1858) noted reptile and fish material in the Kildonnan Member of Eigg ('Hugh Miller's Bone Bed'). Further vertebrate remains have been found recently throughout the Group at several places in the Hebrides (Waldman and Savage, 1972; Harris and Hudson, 1980; Savage, 1984; J.E.

Andrews, 1985; Martill, 1985; Waldman and Evans, 1994; Taylor *et al.,* 1995).

A few fossil fish finds are known from the Upper Cornbrash (*macrocephalus* Zone) of Stilton, Cambridgeshire (Martill 1986), but it is not clear whether the overlying Kellaways Clay has produced others. The overlying Kellaways Sand (*calloviense* Zone) of Lincolnshire recently yielded a diverse fish fauna from a scattering of temporary exposures around Lincoln (Brown, 1990; Brown and Keen, 1991) and in the Peterborough district (Martill, 1985). Some of these fish remains are preserved as associated, but disarticulated, specimens, although isolated fish debris is more commonly recovered from the sandstone (Brown and Keen, 1991). The fauna includes 11 chondrichthyan taxa (the hybodonts *Acrodus, Hybodus, ?Asteracanthus,* and *Lissodus leiodus;* the neoselachians *Palaeospinax* and *Sphenodus;* a hexanchid squalomorph; orectolobid and hemiscylliid galeomorphs; and the chimaeroids *Ganodus semistriatus* and *Ischodus egertoni*) and nine taxa of bony fishes (the semionotid *Lepidotes;* the dapediid *Heterostrophus;* the caturids *Caturus, Osteorachis* and *Heterolepidotus;* and the teleosts *Aspidorhynchus,* an unknown lep-tolepid, an unknown pachycormid and *Leedsichthys;* Brown, 1990; Brown and Keen, 1991). The huge pachycormid *Leedsichthys* is represented by two bones thought to be gill-rakers. Much of the associated material comes from the smaller bony fish, in particular the caturids and *Aspidorhynchus* (Brown and Keen, 1991).

The most spectacular remains of marine faunas derive from the bituminous shale units of the Lower Oxford Clay (particularly the *jason* Zone), and several important museum collections of Oxford Clay vertebrates have been made (for review, see Martill and Hudson, 1991). Many are complete, or nearly complete, articulated skeletons, the result of deposition in undisturbed stagnant bottom waters characteristic of the northern European Jurassic shelf sea (Martill, 1985, 1986, 1988; Martill and Hudson, 1991). The marine vertebrates from the Oxford Clay are particularly well preserved and form a centre-point of all international taxonomic studies. Indeed, the Lower–?Middle Oxford Clay locality at Christian Malford, Wiltshire [ST 957 774], may be the only British fossil Lagerstatte. This site yielded extremely large numbers of beautifully articulated fish and some reptiles in the 19th century (Egerton, 1843), but sadly they were from a temporary exposure and further collections cannot be made (Martin and Hudson, 1991).

Martill (1986) noted isolated fish finds in nearly all Lower Oxford Clay horizons, particularly Beds 7, 8, 10, 11, 13–17 and articulated fish, (including the semionotid *Lepidotes macrochireus* Woodward, and the pachycormids *Asthenocormus* and *Hypsocormus;* Martill, 1986) from the more bituminous fissile shales of Beds 8, 10 and 12 (all *Jason* Zone, Callovian; Callomon, 1968). Some of these fish specimens preserve gut contents, including fragments of the sprat-like teleost *Leptolepis* (Martin, 1986). The Lower Oxford Clay extends from the Dorset coast around Weymouth to the Scarborough coast, Yorkshire. However, there are no good coastal sections and active brickpits form the only sizeable inland exposures for field investigation. The main vertebrate-bearing localities occur around Bedford, Peterborough and Weymouth (Martill, 1986). References include Phillips (1871), A.S. Woodward (1886, 1888c, 1889a, 1890, 1892b, 1896, 1897, 1928, 1929); H.B. Woodward (1895), Arkell (1933), Leeds (1956), Ward and McNamara (1977), Thies (1983), Mandl (1985, 1986, 1989, 1990), Brown and Keen (1991) and Martill and Hudson (1991).

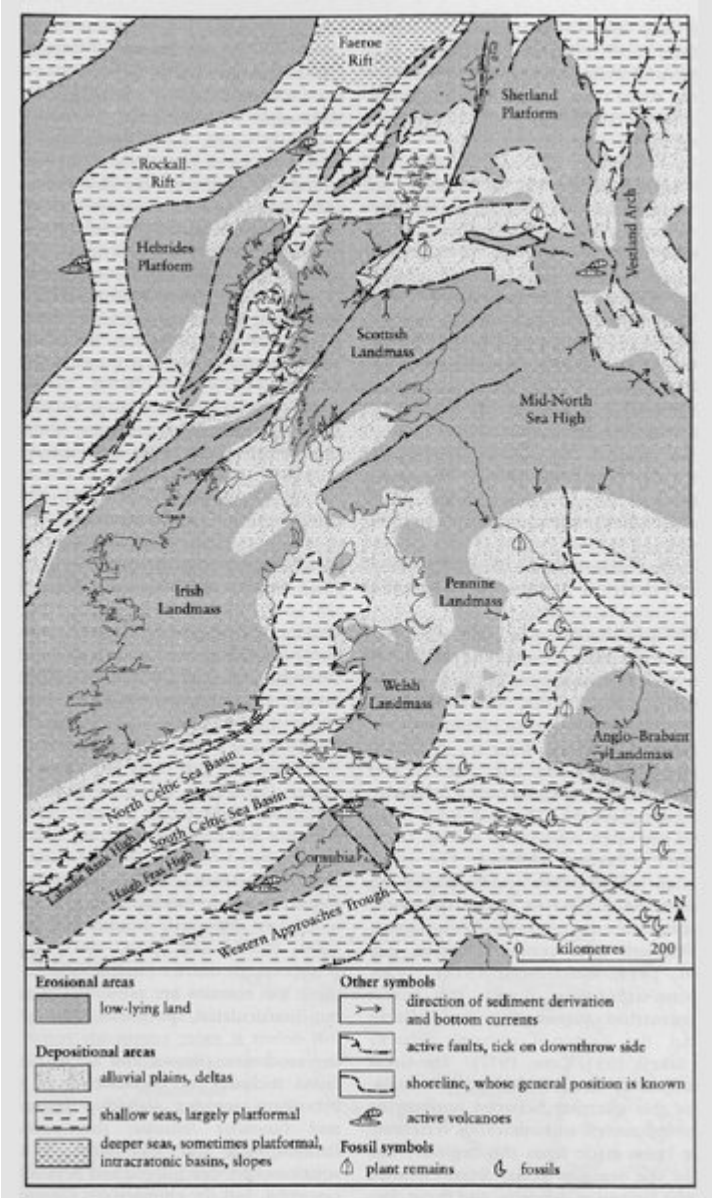
Fish and tetrapod sites

Three fish and tetrapod sites have been selected as GCR sites from the huge numbers that have been noted in the literature, as those representing the greatest range of faunas and preservation types, and as having the greatest potential for future collecting. These are all Bathonian in age; none of the Aalenian or Bajocian sites were reasonably accessible or have yielded material of good preservation, taxonomic interest or quantity. In addition, none of the important Callovian localities could be selected because they have either been lost to infill or degradation, or they are currently worked in a way that prevents the conservation of fossiliferous horizons. In addition, it is not possible to say that any one or two Oxford Clay sites are likely to be more or less productive than any other. The Mid Jurassic sites selected as GCR sites are:

1. Stonesfield, Oxfordshire [SP 387 171]. Mid-Jurassic (Middle Bathonian), Taynton Limestone Formation.
2. Kirtlington Old Cement Works, Kirtlington, Oxfordshire [SP 494 199]. Mid-Jurassic (Upper Bathonian), White Limestone Formation to Lower Cornbrash.

3. Watton Cliff, West Bay, Dorset ([SY 451 908]–[SY 453 907]. Mid-Jurassic (Upper Bathonian), Forest Marble Formation.

References



(Figure 12.13) Palaeogeography of the Middle Jurassic (after Bradshaw et al., 1992).